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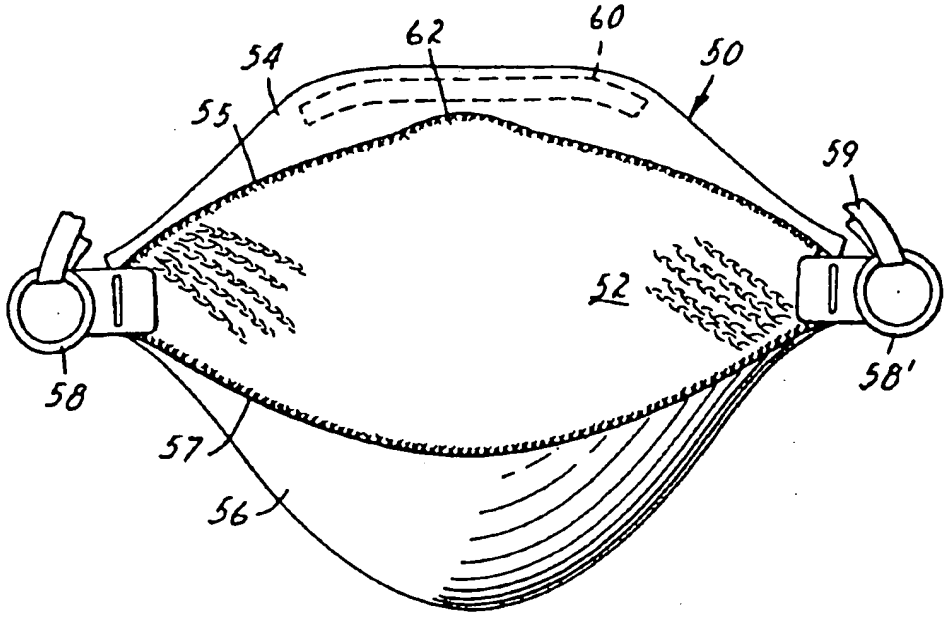

(57) Abstract

A fold flat respirator is provided. The respirator has a central portion having upper and lower edges, and joined to the upper edge of the central portion through either a fold-line or a bond, an upper portion adapted to fit over the nose of a wearer and joined to the lower edge of the central portion through either a fold-line or a bond, a lower portion adapted to fit over the chin of a wearer. At least one of the central, upper and lower portions is formed from filter media and the unjoined edges of the central, upper and lower portions are adapted to contact the nose, cheeks and chin of the wearer. Also provided are processes for producing the respirator.

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FOLD FLAT RESPIRATORS AND PROCESSES FOR PREPARING SAME

Field of the Invention

The present invention relates to respirators or face masks which are capable of being folded flat during storage and forming a cup-shaped air chamber over the mouth and nose of a wearer during use.

Background of the Invention

Filtration respirators or face masks are used in a wide variety of applications when it is desired to protect a human's respiratory system from particles suspended in the air or from unpleasant or noxious gases. Generally such respirators or face masks are of one of two types - a molded cup-shaped form or a flat-folded form. The flat-folded form has advantages in that it can be carried in a wearer's pocket until needed and re-folded flat to keep the inside clean between wearings.

The flat-folded form of face mask has been constructed as a fabric which is rectangular in form and has pleats running generally parallel to the mouth of the wearer. Such constructions may have a stiffening element to hold the face mask away from contact with the wearer's face. Stiffening has also been provided by fusing a pleat across the width of the face mask in a laminated structure or by providing a seam across the width of the face mask.

Also disclosed is a pleated respirator which is centrally folded in the horizontal direction to form upper and lower opposed faces. The respirator has at least one horizontal pleat essentially central to the opposed faces to foreshorten the filter medium in the vertical dimension and at least one additional horizontal pleat in each of these opposed faces. The central pleat is shorter in the horizontal dimension relative to the pleats in the opposed faces which are shorter in the horizontal dimension relative to the maximum horizontal dimension of the filter

medium. The central pleat together with the pleats in opposed faces form a self-supporting pocket.

Also disclosed is a respirator made from a pocket of flexible filtering sheet material having a generally tapering shape with an open edge at the larger end of the pocket and a closed end at the smaller end of the pocket. The closed end of the pocket is formed with fold lines defining a generally quadrilateral surface comprising triangular surfaces which are folded to extend inwardly of the pocket, the triangular surfaces facing each other and being in use, relatively inclined to each other.

More complex configurations which have been disclosed include a cup-shaped filtering facepiece made from a pocket of filtering sheet material having opposed side walls, a generally tapering shape with an open end at the larger end and a closed end at the smaller end. The edge of the pocket at the closed end is outwardly bowed, e.g. defined by intersecting straight lines and/or curved lines, and the closed end is provided with fold lines defining a surface which is folded inwardly of the closed end of the pocket to define a generally conical inwardly extending recess for rigidifying the pocket against collapse against the face of the wearer on inhalation.

Further disclosed is face mask having an upper part and a lower part with a generally central part therebetween. The central part of the body portion is folded backwardly about a vertical crease or fold line which substantially divides it in half. This fold or crease line, when the mask is worn, is more or less aligned with an imaginary vertical line passing through the center of the forehead, the nose and the center of the mouth. The upper part of the body portion extends upwardly at an angle from the upper edge of the central part so that its upper edge contacts the bridge of the nose and the cheekbone area of the face. The lower part of the body portion extends downwardly and in the direction of the throat form the lower edge of the center part so as to provide coverage underneath the chin of the wearer. The mask overlies, but does not directly contact, the lips and mouth of the wearer.

Summary of the Invention

The present invention provides a respirator having a central portion having upper and lower edges, and joined to the upper edge of the central portion through either a fold-line or a bond which can be, for example, a seam or a weld, an upper portion adapted to fit over the nose of a wearer and joined to the lower edge of the central portion through either a fold-line or a bond, a lower portion adapted to fit over the chin of a wearer, at least one of the central, upper and lower portions being formed from filter media and the unjoined edges of the central, upper and lower portions adapted to contact the nose, cheeks and chin of the wearer. Additional portions may be optionally attached to the unjoined edges of the upper and lower portions.

The configuration of the flat-folded respirator may be rectangular to substantially elliptical. The respirator, when unfolded for use, is substantially cup-shaped. The filter media which comprises at least one of the upper, central and lower portions may be a nonwoven fabric such as one formed from microfibers or may be of several layers, each layer having similar or dissimilar filtering properties. The filter media may, of course, also comprise any two or all of the upper, central and lower portions as well as the additional portions.

The respirators of the present invention may further comprise headbands or other means such as adhesive for holding the respirator in place on the face of the wearer, nose clips or any other means to provide good contact of the respirator with the nose of the wearer, exhalation valves, and other accouterments common to respirators and facemasks. When the respirator is constructed with a nose clip, the nose clip may be on the outer portion of the upper panel of the respirator and a cushioning member such as a piece of foam can be placed directly below the nose clip on the inner surface of the upper panel or the nose clip may be on the inner surface of the upper panel and a cushioning member can be placed covering the nose clip or when the respirator comprises multiple layers, the nose clip may be placed between layers.

The respirators or facemasks of the present invention provide better sealing engagement with the wearer's face than some other types of cup-shaped

respirators or face masks which contact the wearer's face at the periphery of the respirator at an acute angle with minimal contact region, thereby increasing discomfort to the wearer and potentially minimizing the engagement of the seal at the perimeter of the respirator.

Additionally provided is a process for producing respirators to afford respiratory protection to a wearer comprising

a) forming a flat central portion of sufficient width to extend across a wearer's face from about cheekbone to cheekbone and over the nose, said central portion having at least an upper edge and a lower edge;

b) attaching a flat upper portion to said central portion at the upper edge of said central portion with a fold, bond or seam, said fold, bond or seam edge of said upper portion being substantially coextensive with said upper edge of said central portion;

c) attaching a flat lower portion to said central portion at the lower edge of said central portion with a fold, bond or seam, said fold, bond or seam edge of said lower portion being substantially coextensive with said lower edge of said central portion;

with the proviso that at least one of said central, upper and lower portions comprises filter media.

Also provided is a process for producing respirators comprising the steps of forming a rectangular sheet of filtering media, folding a first long edge toward the center of the sheet to form an upper portion, folding the second long edge toward the center of the sheet to form a lower portion and sealing the nonfolded edges. The process may optionally include additional portions attached to the upper and lower portions at their unfolded edges through additional folds or bonds.

Further provided is a process for preparing respirators comprising forming a first elliptical sheet of filter media having two edges, forming a second elliptical sheet of filter media having two edges, at least one side of each sheet having a common shape, bonding the common shaped edges, folding the unbonded edge of said second sheet toward the bonded edge, forming a third elliptical sheet of filter

media having two edges, at least one edge of which has a common shape with the unbonded edge of said first sheet, placing said third sheet on said second sheet and bonding the common shaped edges of said first and third sheet.

Each process is amenable to high speed production methods and may comprise additional steps as needed for attachment of headbands, nose clips, and other typical respirator components.

Brief Description of the Drawings

Fig. 1 is a front view of a respirator of the invention in flat-fold configuration.

Fig. 2 is a cross-section taken along line 2-2 of the respirator shown in Fig. 1.

Fig 3 is front view of the respirator of Fig. 1 shown in open ready-to-use configuration.

Fig. 4 is a side view of the respirator of Fig. 1 shown in open ready-to-use configuration.

Fig 5 is a cross-sectional view of another embodiment of a respirator of the present invention in flat-fold configuration.

Fig. 6 is a perspective view of the respirator of Fig. 5 shown partially open.

Fig. 7 is a front view of another embodiment of a respirator of the present invention in flat-fold configuration.

Fig 8 is a front view of the respirator of Fig. 7 shown in open ready-to-use configuration.

Fig. 9 is a front view of another embodiment of a respirator of the present invention.

Fig. 10 is a front view of another embodiment of a respirator of the present invention.

Fig. 11 is a front view of another embodiment of a respirator of the present invention.

Figs. 12a-12p are front views of various additional alternative embodiments of the present invention.

Detailed Description of the Invention

In one embodiment of the invention as shown in FIG. 1, a front view of respirator 10, the respirator has a generally rectangular shape when in the folded form for storage in a package prior to use or in a wearer's pocket. A side view of respirator 10, shown in FIG. 2, shows the respirator having a central portion 12, an upper portion 14 and lower portion 16. The portions are joined, for example, as shown in FIG. 2 by folds 15 and 17, or the upper and lower portions may be bonded or seamed to the central portion. The configuration is held in place by edge seals 11 and 11' which may extend from fold 15 to fold 17 as shown or they may extend partially from fold 15 to fold 17. Edge seals 11 and 11' may be substantially straight as shown or they may be curved. FIGS. 1 and 3 also show attachment means 18, 18' for attaching, for example, a head band to hold the respirator in place on a wearer's face. When the respirator is a multilayer construction, having, for example, filter media layer(s), an optional cover layer, and an optional stiffening layer, the perimeter edges of upper and lower portions 14 and 16 are also bonded.

The respirator 10 is shown in FIGS. 3, and 4, where common parts are identified as in FIGS. 1 and 2, in its opened, ready-to wear configuration having the general shape of a cup or pouch which provides the wearer with the "off-the-face" benefits of a molded cup-shaped respirator. The cup-shaped "off-the-face" design of the respirator of the invention provides a periphery region formed by edges 24 and 26 of the upper and lower portions, respectively, for sealing the respirator against the face of the wearer. FIG. 3 shows respirator 10 with optional nose clip 28. To allow the wearer a greater degree of jaw movement, a generally widthwise fold, or pleat, can be formed in upper portion 14 or lower portion 16 of the respirator, just below the fold or bond 17.

In another embodiment shown in FIGS. 5 and 6, where common parts are identified as in FIGS. 1-4, additional portions 20 and 22 are attached to the upper and lower portions 14 and 16 of respirator 10' by folds 21 and 23 or by bonding or seaming (not shown). Additional portions 20 and 22 may be sealed with central portion 12 and upper and lower portions 14 and 16 at edge seals 11, 11', but preferably are not sealed at the edge seals as shown in Figs 5 and 6 to provide enhanced sealing at the periphery of respirator 10' due to the ability of the additional portions 20 and 22 to pivot at the attachment points 25 and 25'. FIG. 6 shows respirator 10' with optional nose clip 28 located on additional portion 20. In this embodiment, when multiple layers are used to form the respirator, perimeter edges of additional portions 20 and 22 are also bonded.

The width of the central portion 12 of respirator 10 extending between edge seals 11 and 11' or bonds located in the same position as edge seals 11 and 11' is preferably about 160 to 220 mm in width, more preferably about 175 to 205 mm, most preferably about 185 to 190 mm in width. The height of central portion 12 of respirator 10 extending between folds 15 and 17 is preferably about 30 to 110 mm in height, more preferably about 50 to 100 mm in height, most preferably about 75 to 80 mm in height. The width of upper portion 14 and lower portion 16 of respirator 10 are preferably about the same as that of central portion 12. The depth of upper portion 14 extending from fold 15 to the peripheral edge of upper portion 14 of respirator 10 or fold 21 of respirator 10' is preferably about 30 to 110 mm, more preferably about 50 to 70 mm, most preferably about 55 to 65 mm. The depth of lower portion 16 extending from fold 17 to the peripheral edge of lower portion 16 of respirator 10 to fold 23 of respirator 10' is preferably about 30 to 110 mm, more preferably about 55 to 75 mm, most preferably about 60 to 70 mm. The depths of upper portion 14 and lower portion 16 may be the same or different and the sum of the depths of the upper and lower portions preferably does not exceed the height of the central portion. Additional upper and lower portions 20 and 22 in respirator 10' are preferably about the same width as upper and lower portions 14 and 16. Additional upper portion 20 in respirator 10' is

preferably about 1 to 95 mm, more preferably about 5 to 40 mm, most preferably about 5 to 30 mm in depth. Additional lower portion 22 of respirator 10' is preferably about 1 to 95 mm. more preferably about 3 to 75 mm, most preferably about 3 to 35 mm in depth. End edge seals are preferably at about 1 to 25 mm, more preferably about 5-10 mm from the outer edges of central portion 12, upper portion 14 and lower portion 16 and are preferably 1 to 10 mm in width, more preferably 2 to 5 mm in width. When additional portions 20 and 22 are present as in respirator 10' such portions may be, but preferably are not, included in edge seals 11, 11'.

A further embodiment which is referred to as being elliptical in shape is shown in FIGS. 7, 8, 9, 10, and 11. In FIG. 7, respirator 50, shown in front view in its folded, or storage configuration, includes a central portion 52, and bonds 55 and 57. Also shown are attachment means 58, 58' for attaching, for example, a head band 59 to hold the respirator in place on a wearer's face. In FIG. 8, respirator 50 is shown in front view in its ready-for-use unfolded configuration with upper portion 54 bonded to central portion 52 at bond 55 and lower portion 56 bonded to central portion 52 at bond 57. When the respirator is formed of multiple layers of material, the perimeter edges of upper portion 54 and lower portion 56 are also bonded. FIG. 8 further shows a nose clip 60 on upper portion 54 and a protrusion 62 on central portion 52, with a comparable mating protrusion on upper portion 54 (not shown) Nose clip 60 provides improved fit and protrusion 62 with its sister protrusion on upper portion 54 provides improved comfort and fit. In some cases, an improvement in fit can be obtained by folding the upper edge of the upper portion 54 inwards, i.e., towards the face of a wearer. Nose clip 60, if present, can be located inside the fold. To allow the wearer a greater degree of jaw movement, a generally widthwise fold, or pleat, can be formed in upper portion 54 or in lower portion 56 of the respirator, just below the fold or bond 57.

In FIGS. 9, 10 and 11, respirator 50 is shown on the face of a wearer and having a cup-shaped configuration with nose clip 60 being shown in FIG. 9, nose clip 60 and exhalation valve 64 being shown in FIG. 10 and nose clip 60' and

exhalation valve 64 being shown in FIG. 11. Such nose clips and exhalation valves can be equally useful on the respirators shown in FIGS. 1-6.

In the respirator shown in FIGS. 7-11, the width at the widest portion of central portion 52 is preferably about 160 to 220 mm, more preferably about 175 to 205 mm, most preferably about 193 to 197 mm. The height at the highest portion of the central portion, perpendicular to the width, is preferably about 30 to 110 mm, more preferably about 50 to 100 mm, most preferably about 70 to 80 mm. Preferably, the upper and lower portions are substantially the same width as the central portion. The depth at the deepest part of the upper portion is preferably about 30 to 110 mm, more preferably about 40 to 90 mm, most preferably about 50 to 60 mm. The depth at the deepest part of the lower portion is preferably about 30 to 110 mm, more preferably about 50 to 100 mm, most preferably about 60 to 70 mm. The depths of the upper and lower portions may be the same or different. When the depth of the lower portion is greater than that of the upper portion, additional protection can be provided to the chin area. By adjusting the depths of the upper and lower portions as well as the central portion, the fit of the lower portion under the chin can be adjusted or the fit of the upper portion over the nose can be adjusted so that the upper portion rests along the length of the nose or rests predominantly on the bridge of the nose.

The shape of the flat-folded mask, although referred to as generally elliptical with regard to FIGS. 7-11 may vary greatly. It will typically not be a regular ellipse and could, for example, even approach a rhomboid. Various possible shapes of the folded mask are shown in FIGS. 12(a) to 12(p). Thus, a quadrant of the central portion could have a bonded edge configuration approaching a right angle or approaching forming a straight line or a pattern comprising a combination of curves and/or straight lines. Preferably, such a bonded edge has a configuration such as a gentle curve as shown in FIG. 7, more preferably the curve has a radius of about 120 to 170 mm, most preferably about 140 to 150 mm. Similarly, the shape of the upper and lower portions and the upper and lower additional portions may vary considerably. Each of the upper and lower portions must be shaped such that they can be joined to the central portion

as previously described. The shape of the unattached edge portions of the upper and lower portions may also vary from straight to curvilinear as desired to achieve good fit to the wearer's face. The additional upper and additional lower portions, when present, must have an edge portion suitable for joining with the upper or lower edge portion as appropriate. The shape of the unjoined edge portions can range from straight to curvilinear. By varying the shape of the joined portions, the fit of the respirator to the face can be improved by selected design. The bonds connecting the central portion with the upper and lower portions and the additional upper and additional lower portions with the upper and lower portions, respectively, are preferably no more than about 15 mm deep from the edges of the central and upper portions or the edges of the central and lower portions, more preferably no more than about 10 mm deep, most preferably no more than about 5 mm deep and may be continuous or discontinuous.

The filter media or material of the present invention which must comprise at least one of the upper, central and lower portions may be comprised of a number of woven and nonwoven materials, a single or a plurality of layers, with or without an inner or outer cover or scrim, and with or without a stiffening means. Preferably, the central portion is provided with stiffening means. Examples of suitable filter material include microfiber webs, fibrillated film webs, woven or nonwoven webs (e.g., airlaid or carded staple fibers), solution-blown fiber webs, or combinations thereof. Fibers useful for forming such webs include, for example, polyolefins such as polypropylene, polyethylene, polybutylene, poly(4-methyl-1-pentene) and blends thereof, halogen substituted polyolefins such as those containing one or more chloroethylene units, or tetrafluoroethylene units, and which may also contain acrylonitrile units, polyesters, polycarbonates, polyurethanes, rosin-wool, glass, cellulose or combinations thereof.

Fibers of the filtering layer are selected depending upon the type of particulate to be filtered. Proper selection of fibers can also affect the comfort of the respirator to the wearer, e.g., by providing softness or moisture control. Webs of melt blown microfibers useful in the present invention can be prepared as described, for example, in Wente, Van A., "Superfine Thermoplastic Fibers" in

Industrial Engineering Chemistry, Vol. 48, 1342 et seq. (1956) and in Report No. 4364 of the Navel Research Laboratories, published May 25, 1954, entitled "Manufacture of Super Fine Organic Fibers" by Van A. Wente et al. The blown microfibers in the filter media useful on the present invention preferably have an effective fiber diameter of from 3 to 30 micrometers, more preferably from about 7 to 15 micrometers, as calculated according to the method set forth in Davies, C.N., "The Separation of Airborne Dust Particles", Institution of Mechanical Engineers, London, Proceedings 1B, 1952.

Staple fibers may also, optionally, be present in the filtering layer. The presence of crimped, bulking staple fibers provides for a more lofty, less dense web than a web consisting solely of blown microfibers. Preferably, no more than 90 weight percent staple fibers, more preferably no more than 70 weight percent are present in the media. Such webs containing staple fiber are disclosed in U.S. Pat. No. 4,118,531 (Hauser), which is incorporated herein by reference.

Bicomponent staple fibers may also be used in the filtering layer or in one or more other layers of the filter media. The bicomponent staple fibers which generally have an outer layer which has a lower melting point than the core portion can be used to form a resilient shaping layer bonded together at fiber intersection points, e.g., by heating the layer so that the outer layer of the bicomponent fibers flows into contact with adjacent fibers that are either bicomponent or other staple fibers. The shaping layer can also be prepared with binder fibers of a heat-flowable polyester included together with staple fibers and upon heating of the shaping layer the binder fibers melt and flow to a fiber intersection point where they surround the fiber intersection point. Upon cooling, bonds develop at the intersection points of the fibers and hold the fiber mass in the desired shape. Also, binder materials such as acrylic latex or powdered heat activatable adhesive resins can be applied to the webs to provide bonding of the fibers.

Electrically charged fibers such as are disclosed in U.S. Pat. No. 4,215,682 (Kubik et al.), U.S. Pat. No. 4,588,537 (Klasse et al.) which are incorporated herein by reference, or by other conventional methods of polarizing or charging

electrets, e.g., by the process of U.S. Pat. No. 4,375,718 (Wadsworth et al.), or U.S. Pat. No. 4,592,815 (Nakao), which are incorporated herein by reference are particularly useful in the present invention. Electrically charged fibrillated-film fibers as taught in U.S. Pat. No. RE. 31,285 (van Turnhout), also incorporated herein by reference, are also useful. In general the charging process involves subjecting the material to corona discharge or pulsed high voltage.

Sorbent particulate material such as activated carbon or alumina may also be included in the filtering layer. Such particle-loaded webs are described, for example, in U.S. Pat. No. 3,971,373 (Braun), U.S. Pat. No. 4,100,324 (Anderson) and U.S. Pat. No. 4,429,001 (Kolpin et al.), which are incorporated herein by reference. Masks from particle loaded filter layers are particularly good for protection from gaseous materials.

At least one of the upper, central and lower portions of a respirator or facemask of the present invention must comprise filter media. Preferably at least two of the upper, central and lower portions comprise filter media and all of the upper, central and lower portions may comprise filter media. The portion(s) not formed of filter media may be formed of a variety of materials. The upper portion may be formed, for example, from a material which provides a moisture barrier to prevent fogging of a wearer's glasses, or of a transparent material which could extend upward to form a face shield. The central portion may be formed of a transparent material so that lip movement by the wearer can be observed.

Where the central portion is bonded to the upper and/or lower portions, bonding can be carried out by ultrasonic welding, adhesive bonding, stapling, sewing, thermomechanical, pressure, or other suitable means and can be intermittent or continuous. Any of these means leaves the bonded area somewhat strengthened or rigidified. Such bonding means are also suitable for securing the end portions of the respirators shown in FIGS. 1-6.

The respirators of the present invention are preferably held in place on a wearer's face by means well-known to those skilled in the art such as by adhesive or with straps or headbands secured to the respirator main body, formed by the upper, central and lower portions of the respirator, or the upper and/or lower

additional portions of the respirator, at outboard positions on either the outer or inner surface of the respirator by such means as loops which may be integrally formed with the respirator shown in, for example, FIGS 1 and 2, or they may be adhered to the respirator main body by means such as embossing, stapling, adhesive bonding, ultrasonic welding, sewing or other means commonly known to those skilled in the art. Alternatively, the straps or headbands may be directly attached to the respirator main body using means similar to those described for securement of the loop attachment means. Preferably, the headband has some degree of adjustability to effect tension against the wearer's face.

Straps or headbands useful in the present invention are preferably constructed from resilient polyurethane, polyisoprene, butylene-styrene copolymers such as, for example, KRATON™ thermoplastic elastomers available from Shell Chemical Co., but also may be constructed from elastic rubber, or a covered stretch yarn such as LYCRA™ available from DuPont Co. Non-elastic bands useful in the present invention include, for example, non-woven materials formed by both wet-laid or dry-laid processes and consisting of rayon, polyester or like fibers, calendared spun-bonded webs of polypropylene, polyethylene or polyester and reinforced paper. The bands may either be tied, clasped, or stretched such that the bands encircle the head of the wearer bringing the facemask in sealing engagement with the face of the wearer. The alternative band designs also can include open-loop or closed loop constructions to encircle the head of the wearer or loop over the ears of the wearer. U.S. Pat. No. 5,237,986 (Seppala et al.) discloses a headband assembly which enables the mask to be easily and quickly applied, and provides for temporary storage during non-use periods.

A nose clip useful in the respirator of the present invention may be made of, for example, a pliable dead-soft band of metal such as aluminum or plastic coated wire and can be shaped to fit the mask comfortably to a wearer's face. Particularly preferred is a non-linear nose clip configured to extend over the bridge of the wearer's nose having inflections disposed along the clip section to afford wings that assist in providing a snug fit of the mask in the nose and cheek area as shown in FIG. 11. The nose clip may be secured to the mask by an adhesive, for

example, a pressure sensitive adhesive or a liquid hot-melt adhesive. Alternatively, the nose clip may be encased in the body of the mask or it may be held between the mask body and a fabric or foam that is mechanically or adhesively attached thereto. In a preferred embodiment of the invention, the nose clip is positioned on the outside part of the upper portion and a foam piece is disposed on the inside part of the upper portion of the respirator in alignment with the nose clip.

The respirator may also include an optional exhalation valve, typically a diaphragm valve, which allows for the easy exhalation of air by the user. An exhalation valve having extraordinary low pressure drop during exhalation for the mask is described in U.S. Pat. No. 5,325,892 (Japuntich et al.) which is incorporated herein by reference. Many exhalation valves of other designs are well known to those skilled in the art. The exhalation valve is preferably secured to the respirator central portion, preferably near the middle of the central portion, by sonic welds, adhesion bonding, mechanical clamping or the like. Preferably the exhalation valve is sonically welded to the front panel of filtering face mask.

Examples

Respirators or facemasks of the present invention are further described by way of the non-limiting examples set forth below:

Example 1

Two sheets (350 mm x 300 mm) of electrically charged melt blown polypropylene microfibers were placed one atop the other to form a layered web having a basis weight of 100 g/m^2, an effective fiber diameter of 7 to 8 microns, and a thickness of about 1 mm. An outer cover layer of a light spunbond polypropylene web (350 mm x 300 mm; 50 g/m^2, Type 105OB1UO0, available from Don and Low Nonwovens, Forfar, Scotland, United Kingdom) was placed in contact with one face of the microfiber layered web. A strip of polypropylene support mesh (380 mm x 78 mm; 145 g/m^2, Type 5173, available from Intermas, Barcelona, Spain) was placed widthwise on the remaining microfiber surface

approximately 108 mm from one long edge of the layered microfiber web and 114 mm from the other long edge of the layered microfiber web and extending over the edges of the microfiber surface. An inner cover sheet (350 mm x 300 mm; 23 g/m^2, LURTASIL™ 6123, available from Spun Web UK, Derby, England, United Kingdom) was placed atop the support mesh and the remaining exposed microfiber web. The five-layered construction was then ultrasonically bonded in a rectangular shape roughly approximating the layered construction to provide bonds which held the layered construction together at its perimeter forming a top edge, a bottom edge and two side edges. The layers were also bonded together along the long edges of the support mesh. The length of the thus-bonded construction, measured parallel to the top and bottom edges, was 188 mm; and the width, measured parallel to the side edges was 203 mm. The edges of the strip of support mesh lay 60 mm from the top edge of the layered construction and 65 mm from the bottom edge of the construction. Excess material beyond the periphery of the bond was removed, leaving portions beyond the bond line at the side edges, proximate the centerline of the support mesh, 50 mm long x 20 mm wide to form headband attachment means.

The top edge of the layered construction was folded lengthwise proximate the nearest edge of the support mesh to form an upper fold such that the inner cover contacted itself for a distance of 39 mm from the upper fold to form an upper portion, the remaining 21 mm of layered construction forming an additional top portion. The bottom edge of the layered construction was folded lengthwise proximate the nearest edge of the support mesh to form a lower fold such that the inner cover contacted itself for a distance of 39 mm to form a lower portion, the remaining 26 mm forming the additional lower portion. The inner cover layer of the additional upper portion and the additional lower portion were then in contact with each other. The contacting portions of the central portion, lying between the upper and lower folds, the upper portion and the lower portion were sealed at their side edges.

A malleable nose clip about 5 mm wide x 140 mm long was attached to the exterior surface of the additional upper portion and a strip of nose foam about 15

mm wide x 140 mm long was attached to the inner surface of the additional upper portion substantially aligned with the nose clip. The additional upper and lower portions were folded such that the outer covers of each contacted the outer cover of the upper and lower potions, respectively.

The free ends of the layered construction left to form headband attachment means were folded to the bonded edge of the layered construction and bonded to form loops. Head band elastic was threaded through the loops to provide means for securing the thus-formed respirator to a wearer's face.

Example 2

First and second layered sheet constructions (350 mm x 300 mm) were prepared as in Example 1 except the support mesh was omitted. A curvilinear bond was formed along a long edge of each sheet and excess material beyond the convex portion of the bond was removed. A third layered sheet construction was prepared as in Example 1 except each of the five layers was substantially coextensive. The first layered sheet construction was placed atop the third layered sheet construction with inner covers in contact. The first and third sheet constructions were bonded together using a curvilinear bond near the unbonded long edged of the first sheet construction to form an elliptical upper respirator portion having a width of 165 mm and a depth of 32 mm. The radius of each of the curvilinear bond was 145 mm.

The edge of the first sheet construction not bonded to the third sheet was folded back toward the edge of the first sheet which was bonded to the third sheet. The second sheet construction was placed atop the folded first sheet and partially covered third sheet. The second and third sheet construction were bonded together using a curvilinear bond to form an elliptical lower respirator portion from the second sheet having a width of 165 mm and a depth of 32 mm and an elliptical central respirator portion having a width of 165 mm and a height of 64 mm from the third sheet construction. The material outside the elliptical portions was removed. The upper and lower portions were folded away from the central portion.

A malleable aluminum nose clip was attached to the exterior surface of the periphery of the upper portion and a strip of nose foam was attached to the interior surface in substantial alignment with the nose clip. Headband attachment means were attached at the points where the bonds between the central portion and the upper and lower portions met, and head band elastic was threaded through the attachment means to form a respirator ready for a wearer to don.

The various modifications and alterations of this invention will be apparent to those skilled in the art without departing from the scope and spirit of this invention and this invention should not be restricted to that set forth herein for illustrative purposes.

What is claimed is:

1. A respirator having a central portion having upper and lower edges, and joined to the upper edge of the central portion through either a fold-line or a bond an upper portion adapted to fit over the nose of a wearer and joined to the lower edge of the central portion through either a fold-line or a bond a lower portion adapted to fit over the chin of a wearer, at least one of the central, upper and lower portions being formed from filter media and the unjoined edges of the central, upper and lower portions adapted to contact the nose, cheeks and chin of the wearer.

2. The respirator of claim 1 wherein said central portion is substantially rectangular.

3. The respirator of claim 2 wherein said central portion is about 160 to 220 mm in width and about 30 to 110 mm in height.

4. The respirator of claim 2 wherein said upper portion is rectangular.

5. The respirator of claim 4 wherein said upper portion is about 160 to 220 mm wide and about 30 to 110 mm deep.

6. The respirator of claim 2 wherein said lower portion is rectangular.

7. The respirator of claim 6 wherein said lower portion is about 160 to 220 mm wide and about 30 to 110 mm deep.

8. The respirator of claim 2 wherein said respirator further comprises an additional upper portion attached to said upper portion by a fold or a bond.

9. The respirator of claim 8 wherein said additional upper portion is rectangular.

10. The respirator of claim 9 wherein said additional upper portion is about 160 to 220 mm wide and about 5 to 95 mm deep.

11. The respirator of claim 2 further comprising an additional lower portion.

12. The respirator of claim 11 wherein said additional lower portion is rectangular.

13. The respirator of claim 12 wherein said additional lower portion is about 160 to 220 mm wide and about 3 to 95 mm in depth.

14. The respirator of claim 1 wherein said central portion is substantially elliptical in shape.

15. The respirator of claim 14 wherein said central portion is about 160 to 220 mm wide and about 30 to 110 mm high.

16. The respirator of claim 14 wherein said upper portion is substantially elliptical in shape.

17. The respirator of claim 16 wherein said upper portion is about 160 to 220 mm wide and about 30 to 110 mm high.

18. The respirator of claim 14 wherein said lower portion is substantially elliptical in shape.

19. The respirator of claim 18 wherein said lower portion is about 160 to 220 mm wide and about 30 to 110 mm high.

20. The respirator of claim 1 wherein said respirator is a multilayer construction.

21. The respirator of claim 20 wherein at least one layer is of melt blown microfibers.

22. The respirator of claim 21 wherein said melt blown microfibers are electrically charged.

23. The respirator of claim 21 wherein said melt blown microfiber layer is covered by an outer cover spunbond layer.

24. The respirator of claim 21 wherein said melt blown microfiber layer is covered by an inner cover spunbond layer.

25. The respirator of claim 20 wherein at least the central portion has a stiffening layer.

26. The respirator of claim 1 further comprising a nose clip in the upper portion.

27. The respirator of claim 1 further comprising an exhalation valve.

28. The respirator of claim 27 wherein the exhalation valve is located in the central portion of the respirator.

29. The respirator of claim 1 further comprising headband attachment means.

30. The respirator of claim 1 further comprising a headband.

31. A process for producing respirators to afford respiratory protection to a wearer comprising

a) forming a flat central portion of sufficient width to extend across a wearer's face from about cheekbone to cheekbone over the nose area, said central portion having at least an upper edge and a lower edge;

b) attaching a flat upper portion to said central portion at the upper edge of said central portion with a fold, bond or seam, said fold, bond or seam edge of said upper portion being substantially coextensive with said upper edge of said central portion;

c) attaching a flat lower portion to said central portion at the lower edge of said central portion with a fold, bond or seam, said fold, bond or seam edge of said lower portion being substantially coextensive with said lower edge of said central portion;

with the proviso that at least one of said central, upper and lower portions comprises filter media.

32. A process for producing respirators according to claim 1 comprising the steps of forming a rectangular sheet of filtering media, folding a first long edge toward the center of the sheet to form an upper portion, folding the second long edge toward the center of the sheet to form a lower portion and sealing the nonfolded edges.

33. A process for preparing respirators according to claim 1 comprising forming a first elliptical sheet of filter media having two edges, forming a second elliptical sheet of filter media having two edges, at least one side of each sheet having a common shape, bonding the common shaped edges, folding the unbonded edge of said second sheet toward the bonded edge, forming a third

elliptical sheet of filter media having two edges, at least one edge of which has a common shape with the unbonded edge of said first sheet, placing said third sheet on said second sheet and bonding the common shaped edges of said first and third sheet.

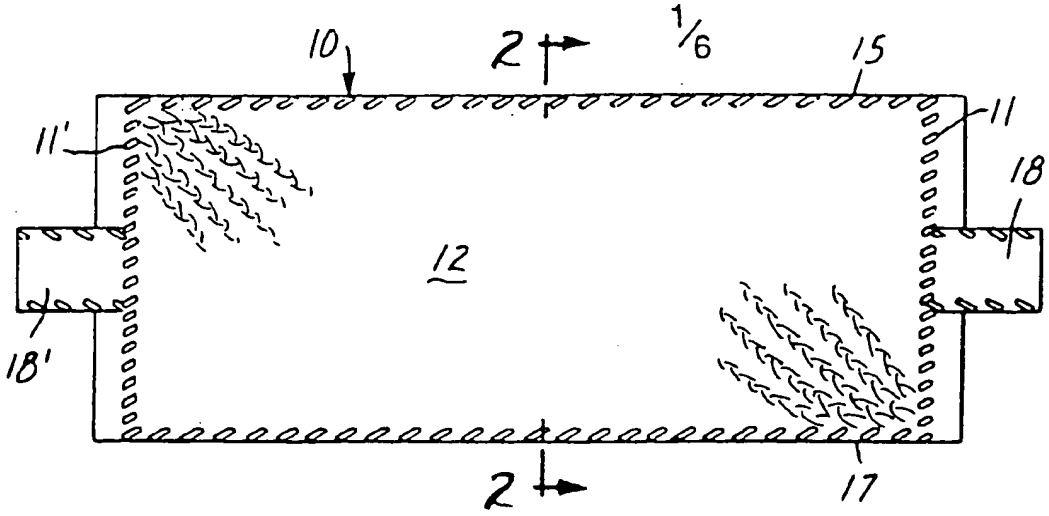

FIG. 1

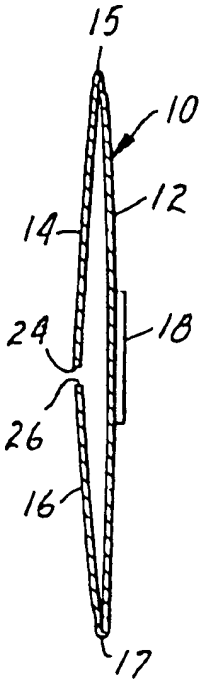

FIG. 2

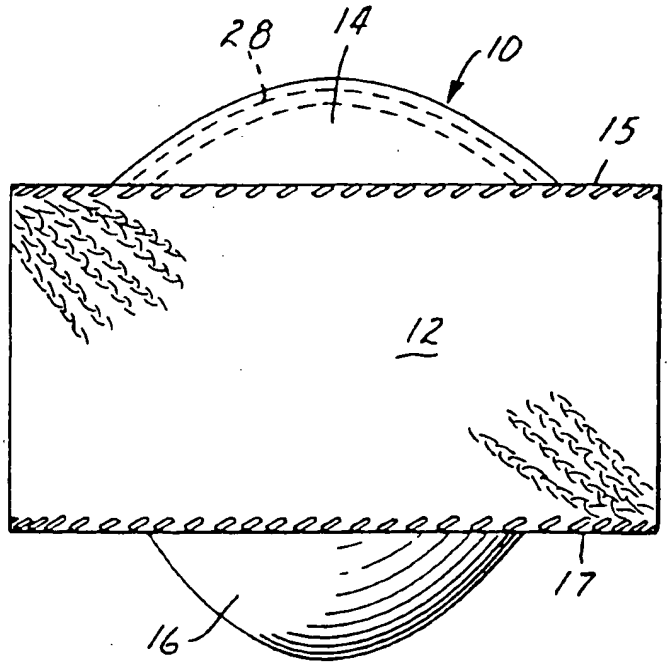

FIG. 3

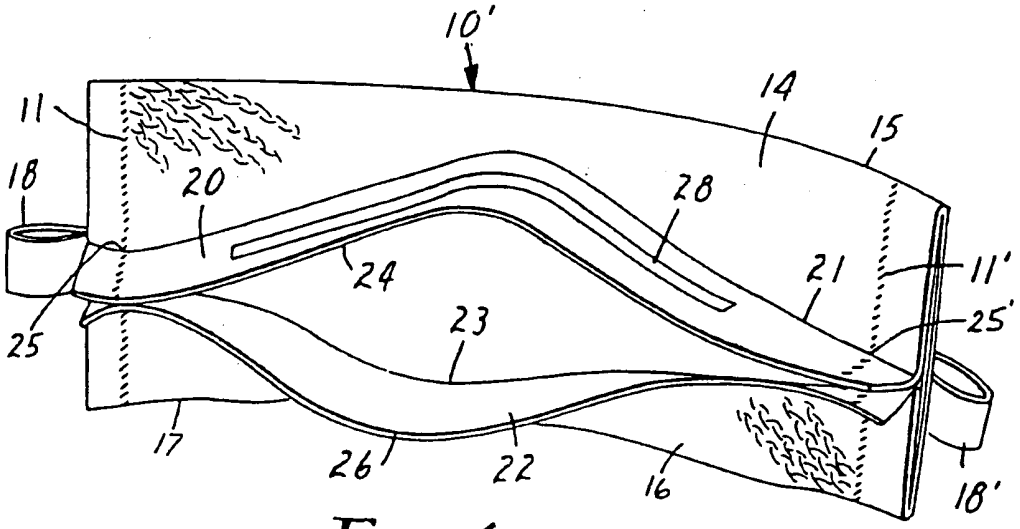

FIG. 6

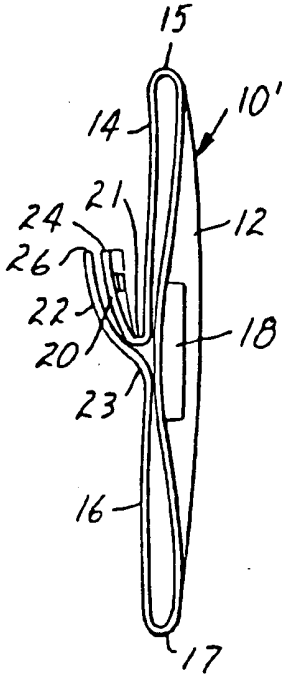

FIG. 5

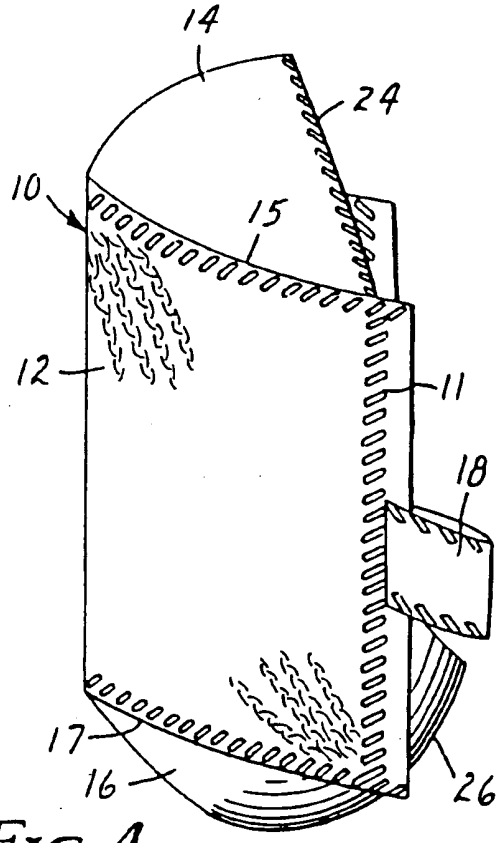

FIG. 4

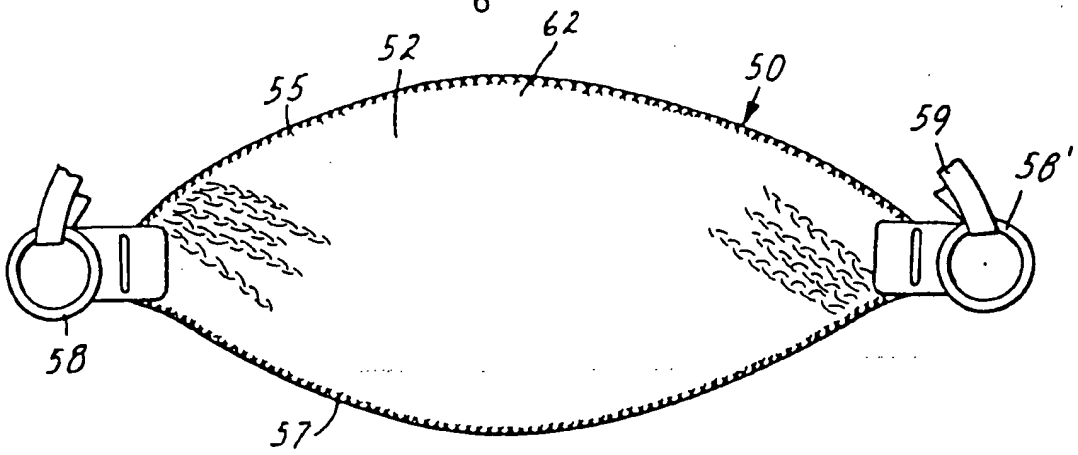

FIG. 7

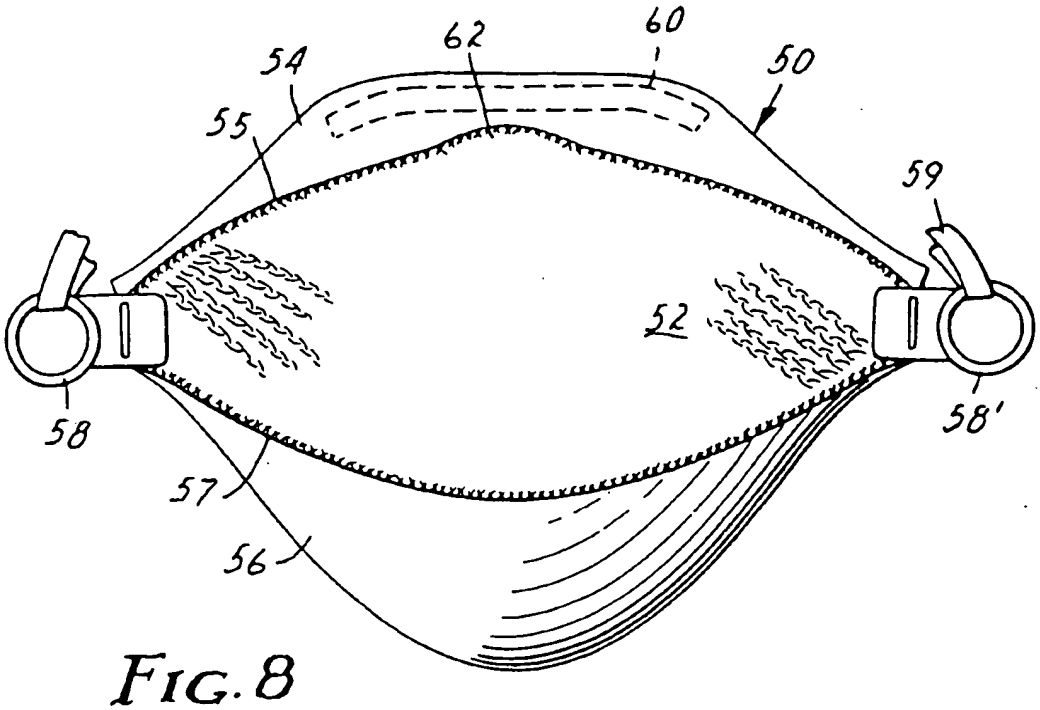

FIG. 8

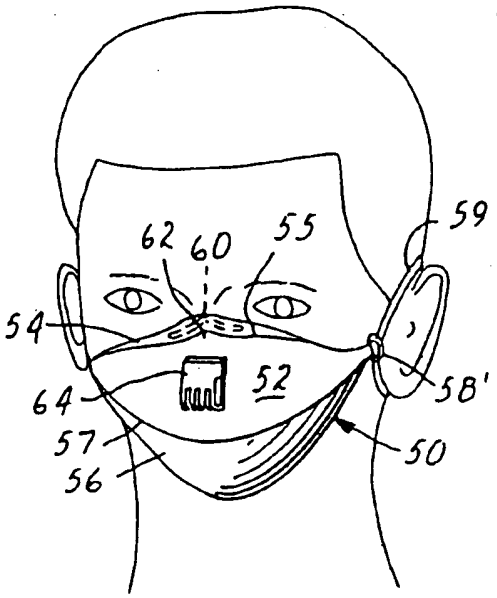

FIG. 10

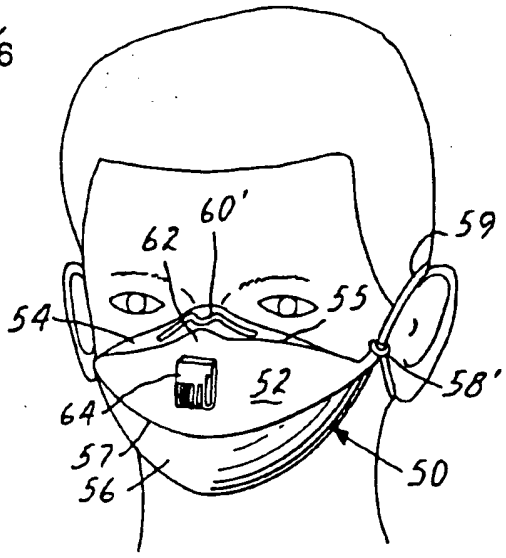

FIG. 11

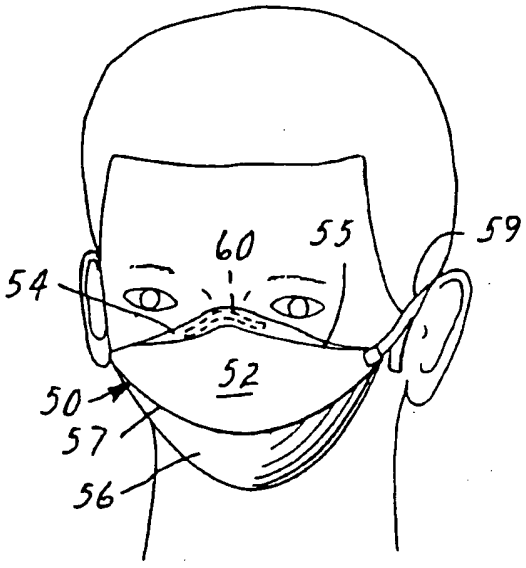

FIG. 9

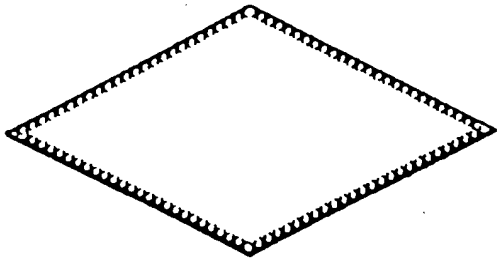

FIG. 12a

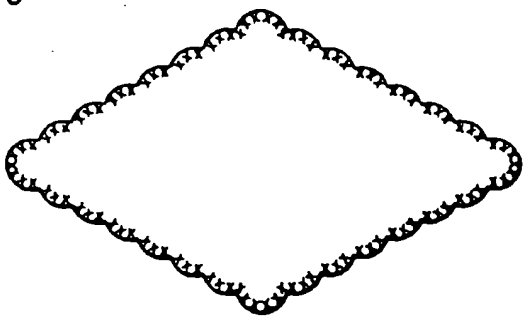

FIG. 12b

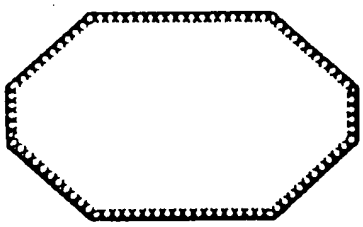

FIG. 12c

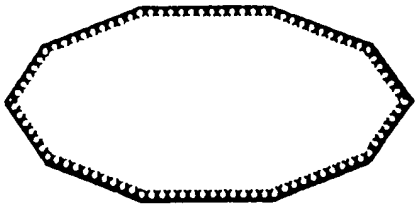

FIG. 12d

FIG. 12e

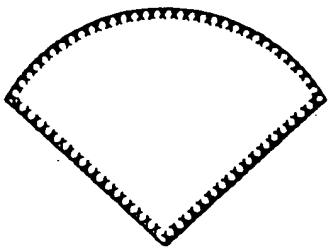

FIG. 12f

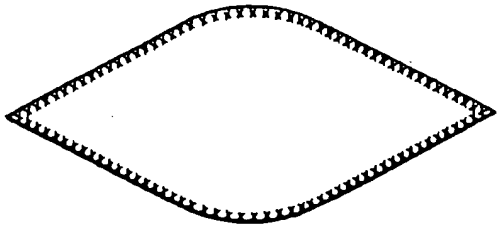

FIG. 12g

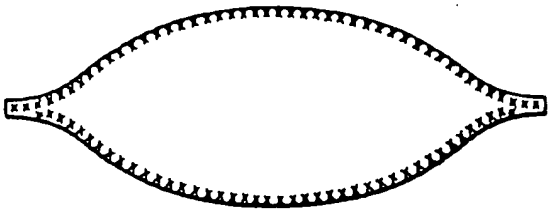

FIG. 12h

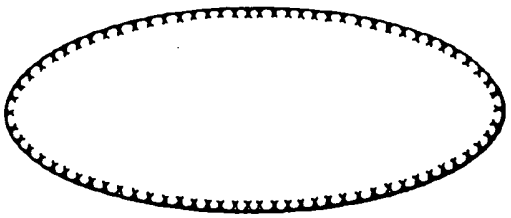

FIG. 12i

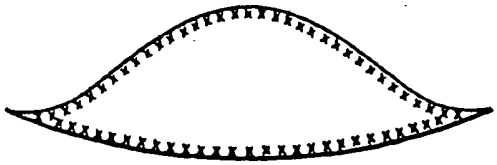

FIG. 12j

FIG. 12k

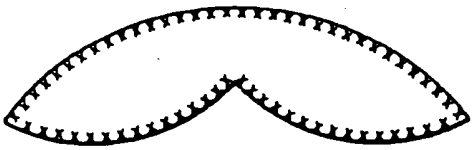

FIG. 12l

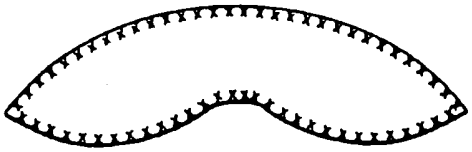

FIG. 12m

FIG. 12n

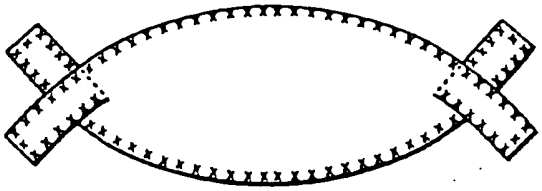

FIG. 12o

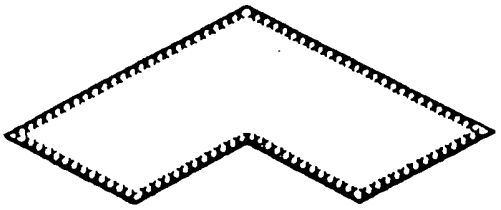

FIG. 12p

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 95/02790

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A62B23/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A62B A41D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A,4 920 960 (HUBBARD) 1 May 1990 see column 2, line 31 - column 4, line 2; figures 1-3	1,2,8, 20,29-33
A	US,A,5 322 061 (BRUNSON) 21 June 1994 cited in the application see column 4, line 32 - column 11, line 34; figures 1-10	1,4,6,8, 9,20, 29-33
A	EP,A,0 183 059 (AMERICAN OPTICAL CORPORATION) 4 June 1986 see column 3, line 20 - column 7, line 35; figures	1,14,20, 26,29-33

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

2

Date of the actual completion of the international search	Date of mailing of the international search report
12 July 1996	22.07.96

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016	Triantaphillou, P

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 95/02790

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A,4 215 682 (KUBIK) 5 August 1980 cited in the application see column 4, line 9 - column 6, line 44 ---	21,22, 29,30
A	US,A,5 325 892 (JAPUNTICH) 5 July 1994 cited in the application see column 4, line 55 - column 11, line 40; figures -----	27-30

2

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 95/02790

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A-4920960	01-05-90	US-A-	5406943	18-04-95
		US-A-	5020533	04-06-91
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		JP-B-	2007671	20-02-90
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		JP-T-	7506751	27-07-95
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		WO-A-	9324181	09-12-93
		US-A-	5509436	23-04-96

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 95/02790

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-5325892		AU-B- 3445995	04-01-96